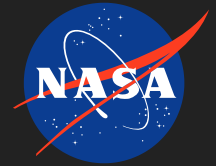


# A Thermal-Electrically Cooled Quantum-Dot Middle-Wave Infrared Photodetector with High Quantum Efficiency and Photodetectivity,

## Phase I

Completed Technology Project (2009 - 2010)



### Project Introduction

Middle-wave infrared (LWIR, 3.2-3.6  $\mu\text{m}$ ) photodetectors with a high specific photodetectivity ( $D^*$ ) are of great importance in NASA's lidar and remote sensing applications. However, existing MWIR photodetectors are required to be operated at low temperature of below 77K to achieve high photodetectivity ( $D^*$ ). The requirement for cryogenic cooling systems adds cost, weight and reliability issues, thereby making it unsuitable for space and planetary exploration applications. The proposed STTR research aims to develop a new type of MWIR photodetector with a significantly enhanced quantum efficiency of  $\sim 60\%$  and photodetectivity of  $> 10^{10} \text{ cm Hz}^{1/2}/\text{W}$ . Successfully developing the proposed innovation is expected to provide an enabling technology for compact high performance MWIR detection and imaging systems suitable for NASA's space exploration and earth remote sensing applications. In phase I, a preliminary MWIR photodetector with the high specific photodetectivity ( $D^*$ ) will be developed and delivered to NASA for proof-of-concept demonstration. In Phase II, an ultra-compact highly-sensitive focal plane array (FPA) prototype will be developed and hybridized with readout circuits. A preliminary high sensitivity LWIR camera will be also demonstrated and delivered to NASA in Phase II.

### Anticipated Benefits

The ultra-sensitive, and spectral tuning capabilities offered by the proposed innovation are particularly useful in many defense and civilian applications requiring ultra-sensitivity operations: (1) Sharp and ultra-sensitive night vision. (2) Missile early launch detection and high-speed trajectory tracking with non-false alarming. (3) Homeland security for trace chemical and biological warfare and hazard detection. (4) High definition IR spectroscopy. (5) Medical diagnoses, leak detection, chemical process control, and atmospheric pollution and drug monitoring. (1) Lidar remote sensing: carbon-based trace gases ( $\text{CO}_2$ ,  $\text{CH}_4$ , and  $\text{CO}$ ), topographical profiling and monitoring of atmospheric variables such as temperature, winds, and trace constituents and mineral identification and vegetation mapping. The high quantum efficiency and high photodetectivity capability offered by the proposed innovation will enable detection of trace elements and high-definition differentiate earth resources such minerals and vegetations. (2) Space telescope for cold star imaging. (3) Real-time high-throughput, high definition acquisition of thermal radiation characteristics of Earth and its environments. The high photodetectivity capability offered by the proposed innovation will allow distinguishing of tiny differences in these radiation characteristics and thus make the analysis of the prediction more accurate.



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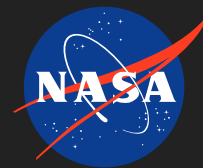
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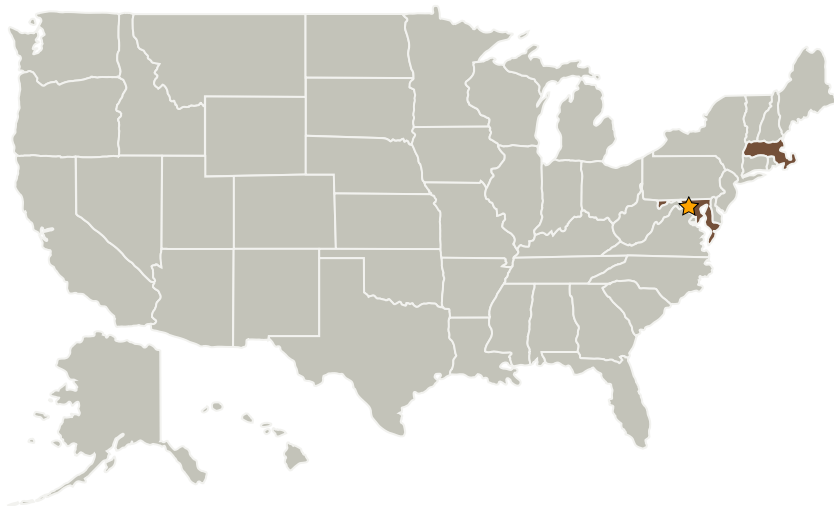
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### Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Goddard Space Flight Center (GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland
Applied NanoFemto Technologies, LLC	Supporting Organization	Industry	Lowell, Massachusetts

### Primary U.S. Work Locations

Maryland	Massachusetts
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### Project Transitions

**January 2009:** Project Start**January 2010:** Closed out

### Organizational Responsibility

#### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

#### Lead Center / Facility:

Goddard Space Flight Center (GSFC)

#### Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

### Project Management

#### Program Director:

Jason L Kessler

#### Program Manager:

Carlos Torrez

#### Project Manager:

Xiaoli Sun

#### Principal Investigator:

Jarrod Vaillancourt

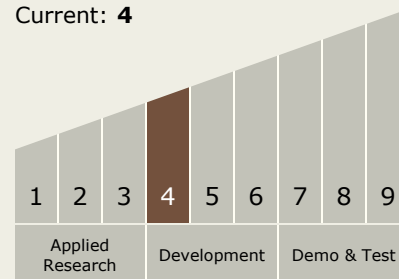
# A Thermal-Electrically Cooled Quantum-Dot Middle-Wave Infrared Photodetector with High Quantum Efficiency and Photodetectivity, Phase I

Completed Technology Project (2009 - 2010)



## Technology Maturity (TRL)

Start: 4  
Current: 4



## Technology Areas

### Primary:

- TX02 Flight Computing and Avionics
  - └ TX02.2 Avionics Systems and Subsystems
    - └ TX02.2.2 Aircraft Avionics Systems